

SB761
U7P3
R91-5



FOREST PEST MANAGEMENT

Pacific Southwest Region

Report Number R91-05

3420
March 21, 1991

AN EVALUATION OF THE VERDI SALE, SIERRAVILLE RANGER DISTRICT, TAHOE NATIONAL FOREST, FOR POTENTIAL IMPACT OF ANNOSUS ROOT DISEASE

John Kliejunas, Plant Pathologist

ABSTRACT

Portions of the proposed Verdi Sale on the Sierraville Ranger District were examined to determine the current incidence and potential future impact of annosus root disease. A summary of observations and studies in the eastside pine and eastside mixed conifer forests suggest that treatment of pine and true fir stumps with borax will prevent disease incidence from increasing. This treatment is recommended for the Verdi Sale. A risk assessment of borax is presented.

INTRODUCTION

At the request of Jane LaBoa, Silviculturist, Tahoe National Forest, I examined portions of the Verdi Sale on the Sierraville Ranger District on February 21, 1991. I was accompanied by District Silviculturist John Kennedy, Planner/Silviculturist Larry Ford, Sale Planner Rachel Condon, and Assistant Culturist Angela Parker-Gunder. The objective of the examination was to provide Forest Pest Management input to the Environmental Assessment for the proposed sale. Specifically, the Forest and the District requested information on the potential impact of annosus root disease in the areas, on the use of borax as a preventive measure for the disease, and information on human and environmental risks associated with the use of borax.

OBSERVATIONS

The Verdi Sale, which is composed of the Verdi Grade, Windmill, and Bear Valley Compartments (Figure 1, Appendix), consists of eastside pine and eastside mixed conifer stands. Tree cover varies from pure ponderosa pine in some portions to, more typically, a mixture of ponderosa pine and white fir with minor amounts of western juniper, sugar pine, and mountain mahogany. The majority of the mixed conifer stands examined were overstocked, with thickets of white fir saplings, poles, and small sawtimber generally scattered throughout. The areas had only limited selective logging in the past.

The preferred alternative for the Environmental Assessment proposes removal of about 15.5 million board feet of timber from 3,466 acres, primarily through commercial thinning. Diameter of material removed, which would be mostly by mechanical harvesters, would range from less than 8 inches dbh to about 22 inches dbh. In the mixed conifer stands we examined, it was estimated that, on the average, 10 to 30 stumps 12 inches or larger in diameter (averaging 14 inches in diameter with a range from 12 to 18 inches) would be created per acre by the mechanical harvesting.

The District has estimated that annosus root disease centers, caused by Heterobasidion annosum, occur on about 2% of the sale area. Evidence of active annosus root disease centers was minimal in the areas we examined. In a recently sheared eastside pine stand near the proposed sale area, no conks of H. annosum were observed in the several ponderosa pine stumps present from previous cuttings. In mixed conifer stands within the proposed sale, several areas with white fir blowdown, and typical laminated decay of H. annosum on the roots were observed. Conks of the pathogen were present in adjacent white fir stumps. Old annosus conks were occasionally found in pine stumps, but mortality of adjacent standing pines was not observed. Stumps created from past selective logging were, in general, few.

Evidence of overstocking, drought stress and activity of other pests were also observed in the mixed conifer stands. Mortality of white fir saplings and poles were common in overstocked portions of the stands. Fir engraver (Scolytus ventralis) attacks were evident on the trees. Several pockets of ponderosa pine mortality in overstocked portions were also present. Western pine beetle (Dendroctonus brevicomis) was present. Dwarf mistletoe was present on white fir (Arceuthobium abietinum f. sp. concoloris) and ponderosa pine (A. campylopodum) in some portions of the stands, but was generally of light intensity.

PROGNOSIS

With no borax treatment of freshly-cut stump surfaces, annosus root disease will likely increase in the Verdi Sale area as commercial thinning occurs. Increased tree mortality and volume loss will result. Evidence for this is based on observations and surveys in other eastside pine and eastside mixed conifer areas in California and in Oregon. If borax is used as a preventive measure, the future incidence of the disease in the stands will remain at current levels and the impact may be considerably less than if borax is not used. Background information in support of these statements follow.

ANNOSUS ROOT DISEASE BIOLOGY AND IMPACT

Biology

Heterobasidion annosum is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. Madrone (Arbutus menziesii), and a few brush species (Arctostaphylos spp. and Artemisia tridentata) are occasional hosts. Other hardwood species are apparently not infected. The disease has been reported on all the National Forests in California, with incidence particularly high on true fir in northern California, in the eastside pine type forests, and in southern California recreation areas.

Annosus root disease is one of the most important conifer diseases in the Region. Current estimates are that the disease infests about 2 million acres of commercial forest land in California, resulting in an annual volume loss of 19 million cubic feet. Other potential impacts of the disease include: increased susceptibility of infected trees to attack by bark beetles, mortality of infected trees presently on the site, the loss of the site for future production, and in recreation areas, depletion of vegetative cover and increased probability of tree failure and hazard.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar. New infection centers are initiated when airborne spores produced by the conks land and grow on freshly cut stump surfaces. Infection in true fir may also occur through fire and mechanical wounds or occasionally, through roots of stumps in the absence of surface colonization. The fungus grows down the stump into the roots and then spreads via root contacts into the root systems of adjacent live trees, resulting in the formation of enlarging disease centers. These infection centers may continue to enlarge until they reach barriers, such as openings in the stand or groups of resistant plants. In pines, the fungus grows through root cambial tissue to the root crown where it girdles and kills the tree. In true fir and other non-resinous species, the fungus sometimes kills trees, but more frequently is confined to the heartwood and inner sapwood of the larger roots. It then eventually extends into the heartwood of the lower trunk and causes chronic decay and growth loss.

Heterobasidion annosum in western North America consists of two intersterility groups, or biological species, the 'S' group and the 'P' group. These two biological species of H. annosum have major differences in host specificity. All isolates of H. annosum from naturally infected ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense-cedar, western juniper, Pinyon, and manzanita have, to date, been of the 'P' group. Isolates from true fir and giant sequoia have been of the 'S' group. This host specificity is not apparent in isolates from stumps, with the 'S' group being recovered from both pine and true fir stumps. These data suggest that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for many years. Young conifers established near these stumps often die shortly after their roots contact infected roots in the soil.

Incidence in Eastside Pine Stands

In eastside pine type forests, incidence of H. annosum is especially high and locally damaging (Wagener and Cave 1946) due to past heavy cutting of pines and an apparently favorable environment for the pathogen. Increased forest

management activity has contributed to an increased incidence of annosus root disease, with the greatest losses being associated with pine stumps left after thinning and harvest cutting operations. Recent surveys (Kliejunas 1989a, 1989b) have found high levels of annosus root disease in the eastside pine type. Levels, which are based on the percentage of pine stumps examined with conks of H. annosum, ranged from 50% on the Modoc, 10% on the Lassen, 22% on the Plumas, and 14% on the Tahoe National Forest. Impact of the disease was especially high on the areas surveyed on the Modoc. About 20% of each acre examined is out of production. A conservative estimate is that about one fifth of the area in non-boraxed timber sales in the eastside pine type on the Modoc National Forest will not produce merchantable pines for the next 20 to 40 years.

Incidence in Eastside Mixed Conifer Stands

Incidence levels of H. annosum in eastside mixed conifer stands in California have not been specifically studied, but are apparently low, based on observations. In Oregon, on the other hand, numerous individual stand surveys show that mortality of 10 to 80% of the trees with 10 to 60% basal area reduction is common (Goheen and Hagle 1988). In one specific survey of a 2,500 acre mixed conifer stand on the Sisters Ranger District, Deschutes National Forest, 19% of all trees over 5 inches dbh, representing 21.8% of the merchantable board foot volume, were killed by root disease during the previous 20 years (Filip 1980).

Factors Affecting Incidence

There is strong evidence that these existing high levels of the disease in eastside pine and eastside mixed conifer forests are largely the result of past selection harvesting, often with repeated entries in the same stand. This partial cutting left numerous infection sites in the form of freshly cut stumps. Results of a survey on two eastside National Forests in Region 6 (Schmitt and others 1984) indicated much higher incidence of true fir infection and mortality in stands that had experienced more than one entry. The average percentage of the true firs infected and killed by H. annosum in the three stand types are presented in Table 1.

Table 1. Incidence of annosus root disease
in relation to stand entry.

Type of Stand	Average Percentage	
	Ochoco	Fremont
Unentered	0	0.04
Entered Once	0.5	1.7
Multiple Entries	2.9	20.8

In surveys of true fir stands in California (Slaughter and Parmeter 1989), the single most important factor associated with annosus root disease in the stands was the presence of stumps. Disease incidence increased as the numbers of stumps from previous cuttings increased.

Efficacy of Borax

Once annosus root disease becomes established in forest stands, no economically feasible procedure for directly suppressing the disease is available. Therefore, prevention is the most efficient and economical method of reducing H. annosum impact. Treatment of freshly-cut pine (Graham 1971) and true fir (Smith 1970) stump surfaces with borax (sodium tetraborate decahydrate) effectively prevents infection by airborne spores of H. annosum. The borax penetrates the stumps to a depth of several inches, and remains toxic to the spores for approximately 2 years. The chemical prevents infection by preventing germination of the spores; it has no effect on existing infections.

Several surveys have indicated the benefit of boraxing pine stumps in eastside pine type stands. On three boraxed sales on the Modoc National Forest, 2 to 4% of stumps boraxed 5 to 11 years previously were infected. Adjacent sale areas of the same age where borax was not used had infection levels of 23 to 70% (Kliejunas 1989a). On the Lassen National Forest, 0 to 2% of the stumps examined in 1986 on three boraxed sales on the Lassen National Forest were infected. Pre-sale surveys in 1975 by Forest Pest Management found that 15% of stumps from previous cuttings were infected with H. annosum. Based on the assumption that, without borax treatment, about 15% of the stumps created would be infected, the decision was made to borax. About 10 years after borax treatment, only 2% of the boraxed stumps were infected (Kliejunas 1989a).

The efficacy of treating true fir stumps with borax to prevent future impact of the disease in a stand is less certain. Although borax does reduce stump infection, one study (Schultz, Parmeter and Slaughter, unpublished) indicated no differences in tree mortality between paired treated and untreated plots in 10 true fir stands 10 years after treatment. In addition, borax treatment of true fir stump surfaces will not prevent the entrance of H. annosum into the root systems of true fir stumps or entrance by other means, nor will it eradicate existing root or stump infections present at the time the tree was cut. The pathogen can enter true fir through logging wounds, and fire scars, and true fir are often infected with the fungus before stand entry.

Stump Diameter and Infection

Policy regarding lower limits of stump diameter to treat with borax varies by forest and district, depending largely on historical information, current observations, and other considerations. In a survey on the Hat Creek Ranger District, Lassen National Forest (DeNitto 1985), only 8 of 83 mortality spots checked did not have stumps greater than 18 inches in diameter as an apparent source of infection. The present policy on the Lassen National Forest in eastside pine type stands is to use borax on all commercial timber sales. Borax is not used in precommercial thinnings, except in those that are mechanically sheared. The survey results support that policy.

Stump diameters were measured during a survey on the McCloud Ranger District, Shasta-Trinity National Forests (DeNitto 1988). Results suggested that stumps less than 14 inches in diameter will not support active annosus infection centers. A survey (Kliejunas 1986) on the Modoc National Forest gave similar results. Stumps less than 18 inches in diameter were not infected. Surveys (Kliejunas 1989) on the Plumas and Tahoe National Forests found only 2 of 173 pine stumps less than 18 inches in diameter with conks.

Borax Recommendations

Treatment of all conifer stumps in recreation sites is directed (FSM 2305.14, R-5 Supplement 164). The same direction should apply to other high value areas, such as progeny test sites or seed orchards, as well. In timber stands, sufficient efficacy information is available to recommend borax treatment of pine stumps, about 12 inches or greater in diameter. The use of borax is especially recommended in areas where surveys have historically indicated high levels of annosus root disease.

Borax treatment of freshly-cut true fir stumps effectively reduces the infection of stump surfaces. However, the efficacy of this treatment is less certain in true fir than in pine because H. annosum can enter true fir root systems through wounds as well as stump surfaces, and above ground crown symptoms indicating current levels of the fungus in the stand are lacking. For these reasons, the decision to treat true fir stumps in timber stands with borax should lie with the appropriate line officer who has been fully briefed on the specific situation in the particular stand in question. This briefing may be in the form of a Forest Pest Management biological evaluation or an on-site visit.

The decision as to what lower pine or true fir stump diameter limit to treat with borax should be based on the risk the forest or district is willing to take versus the cost of the borax treatment. The recommended 12 inch lower limit is based on field observations only rarely indicating H. annosum spreading from smaller diameter, chain saw-created, pine stumps and causing active annosus root disease centers. When thinning by mechanical shearing, which may create stumps at ground level often covered by duff, the risk of infection may be greater. Stump colonization, but not active annosus centers, have been observed in stands thinned by mechanical shearing. However, since the oldest sheared stands in the eastside pine type are only about 10 years old, active centers may not have had time to develop. Until more information is available, the decision as to the lower limit at which to treat sheared stumps should be weighted toward the 8-inch limit indicated by research results (Smith, unpublished).

Borax Risk Assessment

Borax (sodium tetraborate decahydrate) is a registered pesticide (EPA Reg. No. 1624-94), and must be used according to label directions. The label and the Material Safety Data Sheet (see Appendix) contain information on the proper use and on the relative toxicity. Borax treatment on the Tahoe National Forest would require a Pesticide Use Proposal approved by the Forest Supervisor.

For prevention of annosus root disease, borax is applied to freshly-cut stump surfaces at a rate of one pound per 50 square feet of stump surface. This is

equivalent to one pound of borax on 60 twelve-inch stumps. The borax is diffused rapidly into freshly cut stumps to a depth of about 5 centimeters, in quantities sufficient to protect the surface from infection by H. annosum. Although some borax leaches from the stump surface, an appreciable amount remains at the 1.2 cm depth 30 months after treatment (Koenigs, 1971). Some formulations of borax are registered for and used as herbicides for most noxious weeds and grasses. For these decahydrate formulations, recommended rates of dry ground applications by hand or mechanical spreaders is 9 to 15 pounds per 100 square feet (Phelps, Hodges, and Russell, undated).

In terms of human risk, borax has an acute oral LD₅₀ (rats) of 6.13g/kg, an acute dermal LD₅₀ (rabbits) of greater than 10g/kg, and although non-irritating to skin or eyes, may cause slight nasal irritation on inhalation as a nuisance dust. Borax is not a carcinogen. The signal word on the borax label is "Caution", which is equivalent to EPA toxicity category 3, or slightly toxic (LD₅₀ 5,000 to 14,999 mg/kg). The chemical is considered a non-hazardous waste and has been used for years as an additive to laundry detergents.

In terms of environmental effects, borax is relatively benign. It has a low toxicity to fish and wildlife (24 hour LC₅₀ for rainbow trout to borax is 2800 ppm), and is considered to have small or non-existent effects on various soil organisms. An LC₅₀ greater than 100 ppm is considered practically non-toxic to freshwater fish (Zucker 1985), and a LD₅₀ greater than 2,000 ppm is practically non-toxic to mammals (Farringer 1985). This information is consistent with the use of borax for washing clothes. Borax persists in the soil for one or more years depending on soil types and rainfall, with persistence decreasing in acid soils and high rainfall. The decahydrate may not persist beyond one growing season in areas of 35 inches or greater precipitation. Microbial activity probably accounts for the major breakdown of the chemical in soil (Phelps, Hodges, and Russell, undated).

Following procedures used in estimating herbicide doses to deer and rabbits (Vegetation Management FEIS, Appendix F, F-85) resulting from normal forest applications, maximum doses of borax are estimated to be 17.9 mg/kg for deer and 42 mg/kg for rabbits. This estimate is based on a broadcast application of 10 lbs/acre. Actual doses resulting from stump treatment would be expected to be orders of magnitude lower. Using the same procedures for fish and wildlife, broadcast application (not application directly to stumps) of 10 lbs/acre would result in 100 ppb in water. This would give a Q-value of 100 ppb/2800 ppm, or .00004. According to EPA criteria (1986), if the Q-value is less than 0.1, there is no acute toxicity.

The above data suggests that the proper use of borax to prevent annosus root disease poses a very low risk of adverse human or environmental effects. The application rates to stump surfaces (1 pound per 50 sq. ft. of stump surface) are much lower than rates for herbicide use (9 to 15 pounds per 100 square feet of soil). Furthermore, most of the borax applied to stumps diffuses quickly into the stump and is not available for leaching into the ground surrounding the stump.

A calculation of the amount of borax placed in the environment for annosus root disease control (Bill Merrihew, person communication) is presented in Table 2. These numbers, which are only rough averages and would vary from stand to

stand, suggest that about 10 pounds of borax would be applied per acre, per 100 years. This is equivalent to 0.00023 pounds/square foot (10 pounds/acre divided by 43,560 sq. ft.).

Table 2. Borax treatment at one pound per 50 square feet of cut stump.

Year	Type of Stand	Cut Stems/Acre ¹	DBH	Ft2	lbs Borax
0	original			184/50	3.7
20	PCT	200	5	27/50	0.5
70	CT	30	13	28/50	0.6
90	CT	30	15	37/50	0.7
100	final harvest	70	18	124/50	2.5
Total					8.0

¹ Technical Bulletin 630; ponderosa pine, site index 70 and age 200

For the mixed conifer areas examined on the Verdi Sale, 10 to 30 stumps 12 inches or larger in diameter would be created, with the average diameter being about 14 inches (range from 12 to 22 inches). If 14 inches in diameter is approximately equivalent to one square foot (one square foot = diameter of 13.8 inches), then the amount of borax applied to stumps on a per acre basis would range from 0.2 pounds (10 stumps) to 0.6 pounds (30 stumps). If, on the average, 0.4 pounds of borax is used per acre, a 50 pound bag of borax would be sufficient to treat 125 acres. If borax is applied to stumps 12 inches in diameter and larger on the 1,184 acres commercially thinned, the amount applied to the environment would be about 474 pounds on 23,680 stumps (20 stumps/acre X 1,184 acres). The amount would be less if only pine stumps were boraxed.

CONCLUSIONS

Sufficient information exists from observations, surveys, and knowledge of H. annosum biology in eastside pine and eastside mixed conifer forests to state that the incidence of annosus root disease increases as the number of stand entries increase. The effectiveness of borax application to freshly cut stumps as a preventive measure is also documented. Based on the above statements and observations on portions of the proposed Verdi Sale, boraxing of pine and true fir stumps about 12 inches or larger in diameter would prevent H. annosum from increasing in the stands, and is recommended. The manager needs to weigh the benefits of using borax versus the risks of no use in relation to management objectives and the potential impact of the disease on these management objectives.

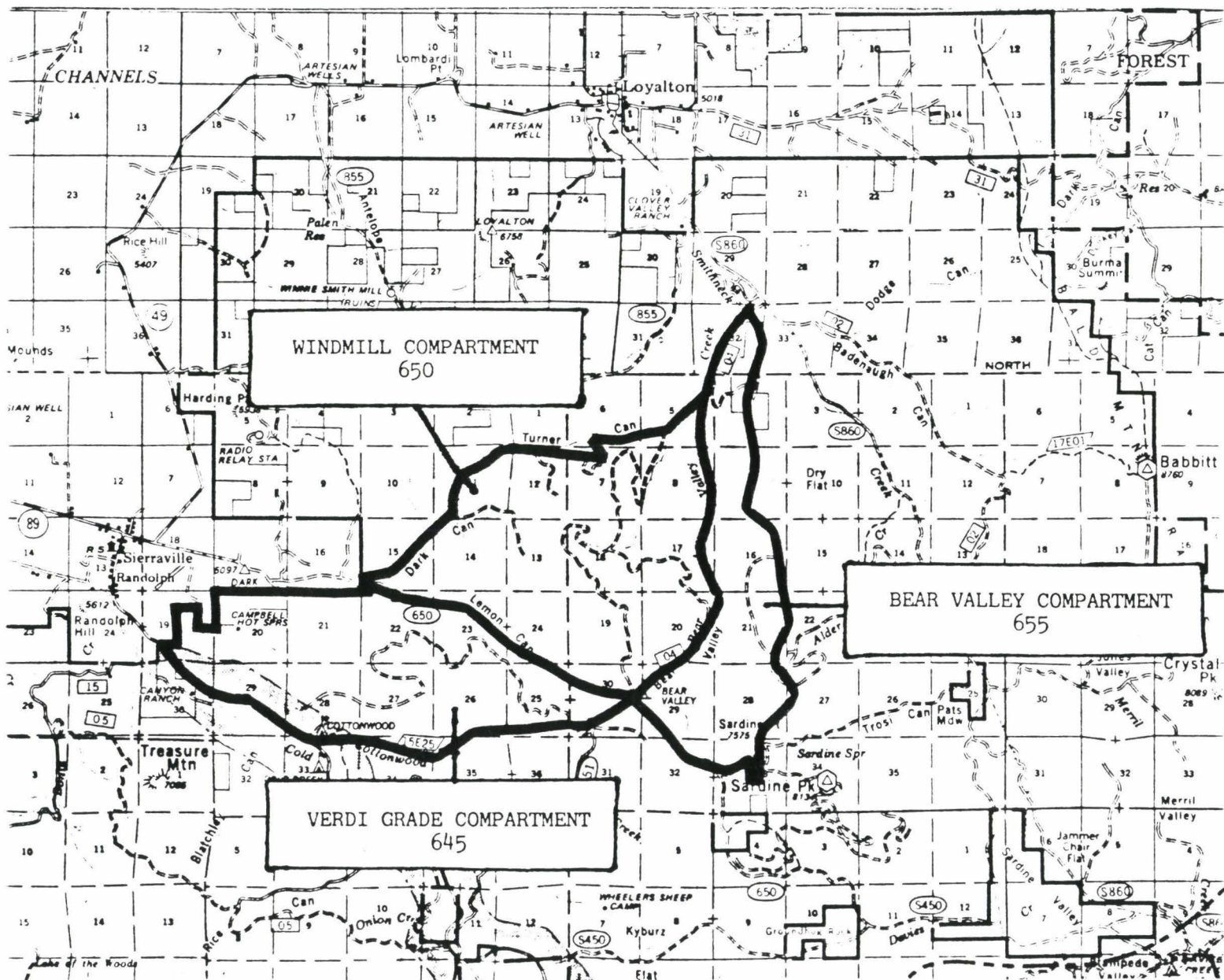
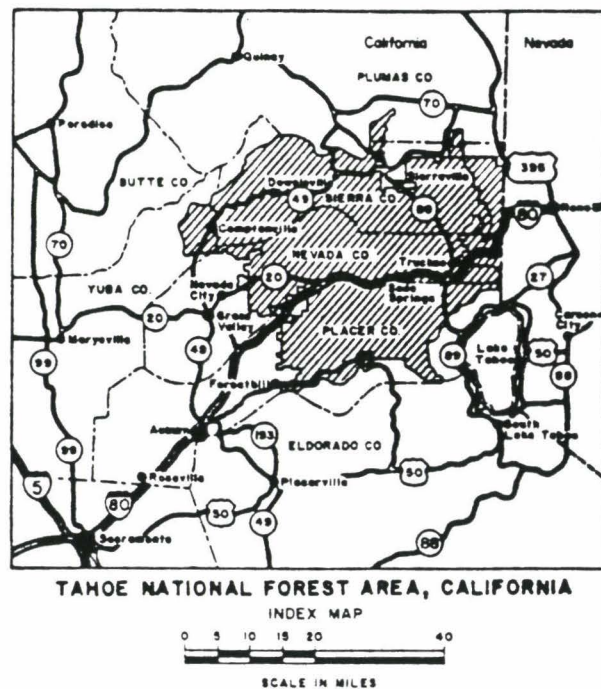
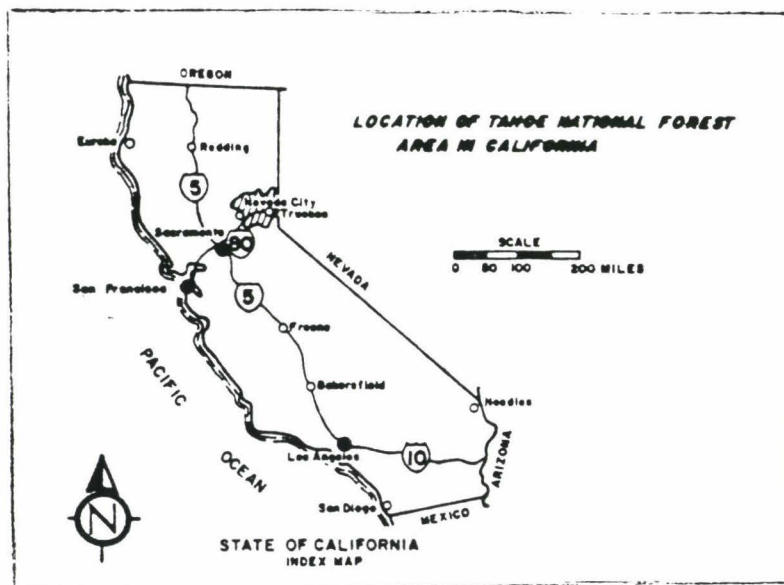
Effective annosus root disease management reduces resource losses to levels which are economically, aesthetically, and environmentally acceptable when measured against the objectives of the forest manager. The impact of the increased incidence of H. annosum that will result if borax is not used will vary with management objectives. For example, the impact will be greater if the objectives are to maintain timber production or site productivity. The impacts may be less if the objectives are noncommodity outputs, where openings in the stand and chronic mortality may be more tolerable, if not desirable. The long term consequences of boraxing or not boraxing now will also influence management options available to the manager in the future. Once damaging levels of H. annosum are present in a stand, management options available become very limited. Borax works effectively to prevent stump infection and it is relatively easy to apply, safe, and inexpensive. The alternatives available to deal with annosus root disease once it is established are expensive, very disruptive to the site, and generally questionable as far as effectiveness.

LITERATURE CITED

- DeNitto, G.A. 1985. Evaluation of Fomes annosus in precommercially thinned pine stands on the Lassen National Forest. Rept. No. 85-36. San Francisco: Pacific Southwest Region, U.S. Department of Agriculture, Forest Service; 2 p.
- DeNitto, G.A. 1988. Evaluation of annosus root disease on McCloud Ranger District. Unnumbered Report. Redding, CA: Northern California Service Area, Pacific Southwest Region, U.S. Department of Agriculture, Forest Service; 3 p.
- Farringer, R. 1985. Wild mammal toxicity test. EPA-540/9-85-004, Office of Pesticide Programs, Washington D.C.
- Filip, G.M. 1980. Timber loss due to root disease in the Wagon Sale Area, Sisters Ranger District, Deschutes National Forest, Oregon. Forest Insect and Disease Management, Pacific Northwest Region; U.S. Department of Agriculture, Forest Service. 30 p.
- Goheen, D.J.; Hagle, S.K. 1988. Root disease response to stand culture. In: Proceedings, Future Forests of the Mountain West: A Stand Culture Symposium; 1986 Sept. 20-Oct. 3; Missoula, MT; U.S. Department of Agriculture, Forest Service, Intermountain Research Station; 303-309.
- Graham, D.A. 1971. Evaluation of borax for prevention of annosus root rot in California. Plant Disease Reporter 55:490-493.
- Kliejunas, J.T. 1985. A biological evaluation of pests associated with the shear and stack technique for precommercial thinning on the Doublehead Ranger District, Modoc National Forest. Rept. No. 85-18. San Francisco: Pacific Southwest Region, U.S. Department of Agriculture, Forest Service; 8 p.
- Kliejunas, J.T. 1986. Incidence of Fomes annosus stump infection on the Doublehead and Devils Garden Ranger Districts, Modoc National Forest. Rept. No. 86-21. San Francisco: Pacific Southwest Region, U.S. Department of Agriculture, Forest Service; 4 p.

- Kliejunas, J.T. 1989a. Borax stump treatment for control of annosus root disease in the eastside pine type forests of northeastern California. p. 159-166 In: Proceedings of the symposium on research and management of annosus root disease (Heterobasidion annosum) in western North America, tech. coord. W.J. Otrosina and R.F. Scharpf. USDA Forest Service Gen. Tech. Report PSW-116.
- Kliejunas, J.T. 1989b. Incidence of Heterobasidion annosum stump infection in eastside pine type stands on the Plumas and Tahoe National Forests. Rept. No. 89-16. San Francisco: Pacific Southwest Region, U.S. Department of Agriculture, Forest Service; 9 p.
- Koenigs, J.W. 1970. Borax: Its toxicity to Fomes annosus in wood and its diffusion, persistence, and concentration in treated stumps of southern pines. Phytopathology 61:269-274.
- Phelps, W.R.; Hodges, C.S., Jr.; Russell, T.V. undated. Background document for borax. Unpublished USDA Forest Service document.
- Schmitt, C.L.; Goheen, D.J.; Goheen, E. Michaels; Frankel, S.J. 1984. Effects of management activities and dominant species type on pest-caused mortality losses in true fir on the Fremont and Ochoco National Forests. Unpublished Impact Evaluation. Forest Pest Management, Pacific Northwest Region, USDA Forest Service.
- Slaughter, G.W.; Parmeter, J.R., Jr. 1989. Annosus root disease in true firs in Northern and central California national forests. P. 70-77 In: Proceedings of the symposium on research and management of annosus root disease (Heterobasidion annosum) in western North America, tech. coord. W.J. Otrosina and R.F. Scharpf. USDA Forest Service Gen. Tech. Report PSW-116.
- Smith, R.S., Jr. 1970. Borax to control Fomes annosus infection of white fir stumps. Plant Disease Reporter 54:872-875.
- U.S. Environmental Protection Agency (EPA). 1986. Guidelines for the health assessment of suspected developmental toxicants. Federal Register 51(85): 34028-34040.
- Wagener, W.W.; Cave, M.S. 1946. Pine killing by the root fungus Fomes annosus in California. Journal of Forestry 44:47-54.
- Zucker, E. 1985. Acute toxicity test for freshwater fish. EPA-540/9-85-006. Office of Pesticide Programs, Washington D.C.

Figure 1. Vicinity Map



USE FOR CONTROL OF
FOMES ANNOSUS IN CONIFER STANDS

It has been established that the fungus, Fomes Annosus, often infects cut conifer stumps following thinning or cutting operations, and that the fungus can spread from infected stumps to residual trees in the stand.

Several chemical agents have been used to limit the development of Fomes Annosus. Research has shown that Borax prevents establishment and growth of Fomes Annosus in cut stumps of conifer tree species not already infected. Borax, a granular, technical chemical, is widely available from distributors of industrial chemicals.

Before using Borax for stump treatment control of Fomes Annosus infection, contact Local, State or Federal Forestry or plant pathology specialists to verify the most economical and efficient methods and materials for your situation.

Use of Borax for this purpose includes all conifer tree species occurring in the stand being treated. Treatment should be limited to stands, or portions of stands, free of Fomes Annosus. Borax should be applied to stump surface of the cut tree as soon after felling as practicable. For most efficient use, apply immediately after cutting but do not delay treatment more than two days.

Best method of application is to sprinkle the material "salt-shaker" style on the freshly cut stump surface. Complete coverage, including exposed side areas and any splinters, is necessary. Also, level rather than sloping stump surfaces is preferred, especially in areas of high rainfall. "Shaker-top" applicators are available in most farm and garden shops in one or two-pound sizes.

Apply enough Borax to lightly cover stump surface. At proper rates of application one pound of granular Borax will adequately cover 50 square feet of stump surfaces; that is, 260 six-inch stumps, 158 eight-inch stumps, 80 ten-inch stumps, or 60 twelve-inch stumps.

Moisture in the exposed wood from freshly cut stumps, dew, or rain, will dissolve the Borax and leach it into the wood.

NOTICE

BORAX is capable of destroying plant life and therefore should not be spilled or dumped into areas underlain with root of valuable vegetation.

Because of many varying conditions affecting use and application, manufacturer warns buyer that these may impair or vary the results or effects of the use of this product. In any event, complete prevention of decay by fungi or other organisms is not guaranteed. Neither manufacturer nor seller shall be liable in respect to any injury or damage suffered by reason of the use of this product for a purpose not indicated by the label or when used contrary to the directions or instructions hereon nor with respect to breach of any warranty not expressly specified herein. Buyer accepts this material subject to these terms, and assumes all risk of usage and handling except when used or handled in accordance with this label. Neither manufacturer nor seller, makes, and their employees and agents are not permitted to make, any representations or warranties, express or implied by law, not specifically set forth herein.

20 MULE TEAM[®]

BORAX

FOR FOMES ANNOSUS CONTROL

*Registered in California
for 1982*

ACTIVE INGREDIENT:

Sodium Tetraborate Decahydrate $(Na_2B_4O_7 \cdot 10H_2O)$ 100.00%
[Boric Oxide (B_2O_3) Equivalent 37.50%]

PRECAUTIONARY STATEMENTS

HAZARD TO HUMANS AND DOMESTIC ANIMALS

CAUTION

Harmful if swallowed. Wash thoroughly after handling.
Avoid contamination of food and feed.

Do not leave container where children or animals may gain access.

ENVIRONMENTAL HAZARDS

BORAX carelessly spilled or applied to cropland or growing plants — including trees and shrubs — may kill or seriously retard plant growth. Do not contaminate water by cleaning of equipment or disposal of wastes.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

KEEP OUT OF REACH OF CHILDREN

CAUTION

SEE SIDE PANEL FOR ADDITIONAL
PRECAUTIONARY STATEMENTS

STORAGE AND DISPOSAL

1. PROHIBITIONS:

Do not contaminate water, food or feed by storage or disposal.
Do not store where children or animals may gain access.
Open burning and dumping prohibited.
Do not reuse empty container.

2. PESTICIDE DISPOSAL:

Pesticide, spray mixture or rinsate that cannot be used or chemically reprocessed should be disposed of according to procedures approved by Federal, State or Local disposal authorities.

3. CONTAINER DISPOSAL:

Consult federal, state or local disposal authorities for approved procedures.

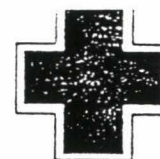
A 20 MULE TEAM[®] Product

U.S. BORAX

Manufactured by:
United States Borax & Chemical Corporation
Los Angeles, CA 90010

EPA Reg. No. 1624-94 EPA Est. 1624-CA-2

Net Weight: 100 LBS. 45.36 KG.



EFFECTIVE DATE: September 1, 1985

SECTION I — PRODUCT IDENTIFICATION

PRODUCT TRADE NAME Borax

CHEMICAL NAME AND SYNONYMS Sodium tetraborate
decahydrate

CAS NO. 1303-96-4

CHEMICAL FAMILY: Borate

FORMULA: $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$

HAZARD RATING: NFPA 0 Health
0 Flammability
0 Reactivity

SECTION II — HAZARDOUS INGREDIENTS

Material or Component	%	Material or Component	%
None			

SECTION III — PHYSICAL DATA

Specific gravity 1.73	Appearance: White, odorless, crystalline solid
Melting point 62°C	
Heat of Solution -122 BTU/lb	
pH 3% Solution: 9.25 @ 20°C	
Solubility in Water: 5.81% @ 20°C 65.63% @ 100°C	

24 HOUR EMERGENCY TELEPHONE NUMBER: (714) 774-2673

CONTACT: J. C. MIDDLETON

"The information and recommendations contained herein are based upon data believed to be correct. However, no guarantee or warranty of any kind expressed or implied is made with respect to the information contained herein."

UNITED STATES BORAX & CHEMICAL CORPORATION • 3075 WILSHIRE BLVD., LOS ANGELES, CA 90010

SECTION IV — HEALTH HAZARD INFORMATION

EFFECTS OF EXPOSURE (SYMPTOMS)

INGESTION:

ACUTE ORAL LD₅₀ (rats) 6.13 g/kg.

Small amounts (up to 15 grams) - slight nausea, vomiting, diarrhea.

Large amounts (15 grams or more) - nausea, vomiting, diarrhea.

EYE: (16CFR §1500.42) Not an eye irritant - may cause slight, reversible conjunctivitis.

SKIN: None

ACUTE DERMAL LD₅₀ (16CFR §1500.40) Greater than 10 g/kg (rabbits).

PRIMARY SKIN IRRITATION INDEX: (16CFR §1500.41) 0

CORROSIVE

NON CORROSIVE: x

INHALATION May cause slight nasal irritation as a nuisance dust.

ACUTE LC₅₀ N/A

EFFECTS OF OVEREXPOSURE**ACUTE OVEREXPOSURE/METHOD OF EXPOSURE/SYMPTOMS**

Inhalation - sneezing, coughing

Eyes - slight irritation

Skin - none known

Ingestion - nausea, vomiting, diarrhea, erythematous flush

CHRONIC OVEREXPOSURE/METHOD OF EXPOSURE/SYMPTOMS

Inhalation - coughing

Eyes - slight conjunctivitis

Skin - none known

Ingestion - erythematous flush, macular skin rash: CNS effects.

See page 6.

OSHA Permissible Exposure LIMIT (PEL) Not Listed

29CFR §1910 Subpart Z

ACGIH Recommended Threshold Limit Value 5 mg/m³ (1984-1985)
No data base.

National Toxicology Program Annual Report on Carcinogens

Year 1983

Listed

Not Listed X

International Agency for Research on Cancer (IARC)

Monograph Yes

No X

OSHA CARCINOGEN NO

EMERGENCY AND FIRST AID PROCEDURES: +

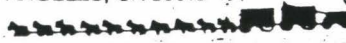
EYES Flush with tepid water for 15 minutes.

SKIN Rinse with water.

INHALATION Remove to fresh air.

(CONT. PAGE 4)

UNITED STATES BORAX & CHEMICAL CORPORATION • 3075 WILSHIRE BLVD., LOS ANGELES, CA 90010

 **USBORAX**

EMERGENCY AND FIRST AID PROCEDURES: +

(CONT. FROM PAGE 3)

INGESTION

Induce emesis. Drink large amounts of water and/or milk. Consult physician.

NOTE TO PHYSICIAN

Not an acute poison. Ingestion of large amounts (15 grams or more) - gastric lavage, with 5% sodium bicarbonate; Saline cathartic. For further medical management, call emergency number on page 1. See page 6.

SECTION V — FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used) Not Applicable FLAMMABLE LIMITS Lel. Uel

EXTINGUISHING MEDIA Fire Retardant

SPECIAL FIREFIGHTING PROCEDURES None

UNUSUAL FIRE AND EXPLOSION HAZARDS None

SECTION VI — REACTIVITY DATA

STABILITY UNSTABLE CONDITIONS TO AVOID

STABLE X

INCOMPATIBILITY (materials to avoid) Elemental Zirconium

HAZARDOUS DECOMPOSITION PRODUCTS None

HAZARDOUS POLYMERIZATION MAY OCCUR WILL NOT OCCUR X

CONDITIONS TO AVOID Avoid heating with elemental zirconium.

SECTION VII — SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Sweep or vacuum. Rinse area with water.

WASTE DISPOSAL METHOD

Solid land fill or sanitary sewer. Not considered hazardous waste.

SECTION VIII — SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type) Nuisance Dust Mask

VENTILATION

LOCAL EXHAUST X

SPECIAL

MECHANICAL (General)

OTHER

PROTECTIVE GLOVES None Required

EYE PROTECTION Glasses Suggested

OTHER PROTECTIVE EQUIPMENT None

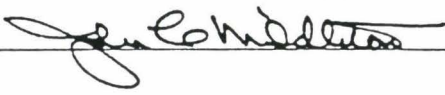
SECTION IX — SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Dry indoor storage.

OTHER PRECAUTIONS Maintain package integrity.

DATE: 9/1/85

SIGNATURE: 

UNITED STATES BORAX & CHEMICAL CORPORATION • 3075 WILSHIRE BLVD., LOS ANGELES, CA 90010



Note:

Two year feeding studies on rats and dogs showed no appreciable accumulation of boron in the body. Ingested borates are dissipated in the urine -- 70% in the first 24 hours. No adverse effects were noted at the 0.31% dietary level.

Complimentary blood analysis available for physicians and emergency rooms. Medical consultation available.